

**NATIONAL METALLURGICAL LABORATORY  
MADRAS CENTRE**

**ANNUAL REPORT  
2010-2011**



**National metallurgical laboratory  
Madras centre  
Csir madras complex, taramani  
Chennai 600 113**

April 2011



**NATIONAL METALLURGICAL LABORATORY  
MADRAS CENTRE  
CHENNAI 600 113  
(An ISO 9001:2008 organisation)**

**ANNUAL REPORT  
(APR 2010– MAR 2011)**

**1. Most significant achievements:**

*Contributions to new knowledge that have helped to advance the frontiers of knowledge or opened up new avenues of thought/R&D etc.: For each (300-500 words).*

Single reagent for beneficiation of coal fines was developed in collaboration with M/s Somu Organo Chem Ltd. Bangalore. The process was demonstrated at Jamadoba Coal Washery of TATA STEEL. Ash % could be reduced to 12-13 % from feed ash of 20-23%. Based on the results TATA STEEL decided to conduct a month long trials to establish the efficacy of the reagent before implementing in their washeries.

**TECHNOLOGY COMMERCIALIZATION:**

1. Commercialization of a 2.5 metre dia. Industrial flotation column for the beneficiation of barytes at Indian Barytes Chemicals Ltd., Mangampeta, Andhra Pradesh is taken up by NMLMC in collaboration with M/s McNally Sayaji Engng. Co. Ltd., Bangalore. NML MC has provided the design for fabrication and specifications for the instrumentation. Project is in progress.

**2. Technology/Knowledge base marketed: (for each 300-500 words)**

a. *Process developed*

Under a collaborative programme with M/s Somu Organo chem Pvt. Ltd., Bangalore for the development of new reagent systems for the beneficiation of ores, flotation reagents were developed and evaluated for the beneficiation of iron ores, iron ore tailings, manganiferous clay, coal, and barytes.

b. *Process related to industry with names of the party*

c. *Processes demonstrated to party with name of party & address:*

d. *Extension services rendered to the licensees*

NIL

e. *Processes under trial & commercial production with names of the party (including such details as tons per annum/investment envisaged—annual turnover at what capacity/price per kg/ton etc.)*

- Testing of single reagent developed jointly by NML and M/s SOMU Organo Chem., Bangalore, is in progress at Coal Preparation Plant, Jamadoba, Tata Steel.
- Installation of industrial scale flotation column is being installed for processing of barites for M/s Indian Barytes & Chemicals Ltd., Managampeta, AP with a size of 2.5 m dia column.

**3. R&D for Industries/Rural Development/Societal/  
National Mission:**

*if any (at least 300 words on each project under the categories given below and also list the members involved).*

- o *Thrust Area Projects: (Ongoing - 1)*

**Ongoing (1)**

**1. Zero Emission Research Initiative**

*Project No:* NWP 44  
*Project duration:* 2007- 2012  
*Project cost:* Rs.67 lakhs

*Scientists/Technical Officers involved:*  
G Bhaskar Raju (PL), S Prabhakar (Co-PL)

*Importance of contribution:*

The objective of the project is technology development for the treatment of sectional wastewaters aimed to achieve zero liquid discharge. The final deliverables are design of electrochemical reactor to improve the efficiency/energy consumption and process development for the treatment of sectional wastewaters.

The following work elements were completed:

- Laboratory scale and pilot scale electrochemical reactors were designed and fabricated.
- Degradation of sectional wastewater containing tannins that are refractive and polymeric in nature was studied by advanced oxidation and electro oxidation techniques. The reusability of processed wastewater was completed.
- Removal of chromium from sectional wastewater was completed.
- Mineralization of some commercial dyes that are extensively used in leather industry and also the typical effluent generated from the dye bath are studied both by electrooxidation and advanced oxidation techniques.
- Removal of pollutants from the tannery wastewater and reusability of treated wastewater with particular reference to quality of leather.

**2. Surface nano-crystallization of carbon steels/alloy steels by surface mechanical attrition treatment (SMAT): Evaluation of microstructural characteristics, mechanical properties, hardness, corrosion resistance and wear resistance**

*Project No:* SIP 0025  
*Project duration:* 2007-2012  
*Project cost:* Rs.50 lakhs  
*Scientists/Technical Officers involved:*

TSN Sankara Narayanan (PL), K. Gopala Krishna (Co-PL), M. Ananda Rao and Nidhi Singh

Project coordinators: Suman K Mishra / I.Chattoraj

- o Interactive Projects NIL
- o Sponsored Investigation Projects NIL
- o International Collaboration

**Sponsored Research Projects (Ongoing - 14, Completed- 13 )**

**1. Treatment of effluents from ossein production plant – pilot scale study**

*Sponsor:* M/s Pioneer Jellice India Pvt Ltd., Cuddalore  
*Project No :* SSP 0615  
*Project duration :* 22/3/11 to 30/9/11  
*Project cost :* Rs.1.0 lakh

*Scientists/Technical officers involved:*  
G Bhaskar Raju (PL), S Prabhakar (Co-PL), S Subba Rao, T V Vijayakumar,  
N Vasumathi

Importance of contribution:

Objective of the project is to ascertain the amenability of electro coagulation technique for the treatment of effluents from ossein production plant. Removal of suspended colloid particulate matter that contribute for COD and BOD would be tried by electrocoagulation.

**2. Characterization studies on Rubber Tiles**

*Sponsor:* M/s Ultra Tiles P Ltd., Chennai  
*Project No :* SSP 0586  
*Project duration :* 20/04/10 to 19/04/12  
*Project cost :* Rs.6.0 lakhs

*Scientists/Technical officers involved:*  
A Rajakumar (PL)

Importance of contribution:

Conformance of physical properties of rubber tiles to relevant ASTM standards. The tests include abrasion resistance, skid resistance, hardness, tensile strength, compression.

**3. Studies on cement tiles**

*Sponsor:* M/s Ultra Tiles P Ltd., Chennai  
*Project No :* SSP 0614  
*Project duration :* 28/11/10 to 27/11/11  
*Project cost :* Rs. 2 lakhs

*Scientists/Technical officers involved:*  
A Rajakumar (PL)

Importance of contribution:

Conformance of physical properties of cement tiles to IS 1237: 1980 (re-affirmed 2000). The project involves characterization studies on cement tiles for their physical properties such as water absorption, wear resistance, wet transverse strength and flatness.

#### **4. Evaluation of corrosion performance of reinforcement steel**

*Sponsor:* M/s N.R.Patel & Co, Chennai  
*Project No :* SSP 0592  
*Project duration :* 29/4/10 to 30/4/11  
*Project cost :* Rs. 1 lakh

*Scientists/Technical officers involved:*  
T S N Sankara Narayanan (PL), Satendra Kumar (Co-PL)

*Importance of contribution:*

To estimate the corrosion resistance of reinforcement steel as per ASTM standards. The scope includes corrosion resistance by salt spray test, potential dynamic polarisation measurement, moist sulphur di-oxide test, chemical analysis and mechanical properties.

#### **5. Chemical analysis of steel billet samples**

*Sponsor:* M/s Sumangala Steels (P) Ltd., Chennai  
*Project No :* SSP 0603  
*Project duration :* 05/05/10 to 31/05/11  
*Project cost :* Rs. 1.48 lakhs

*Scientists/Technical officers involved:*  
T S N Sankara Narayanan (PL), Satendra Kumar (Co-PL)

*Importance of contribution:*

To evaluate the chemical composition of the steel billet samples.

#### **6. Expert opinion on evaluation and classification of MS Re-rollable Steel Scrap**

*Sponsor:* Galaxy Commercial, Chennai  
*Project No :* SSP 0611  
*Project duration :* 05/05/10 to 31/05/11  
*Project cost :* Rs. 1.44 lakhs

*Scientists/Technical officers involved:*  
K Gopalakrishna (PL), M. Ananda Rao (Co-PL), R. Gopalakrishnan

*Importance of contribution:*

Objective of the project is providing expert opinion to Customs by carrying out visual inspection of the consignment at Customs Yard, getting chemical analysis for the samples done and formation of opinion on the classification of the consignment.

#### **7. Consultancy services in supplying industrial scale Column (2.5 m dia.) to Andhra Baryte Corpn. P Ltd, Kadapa**

*Sponsor:* M/s McNally Sayaji Engg Ltd., Bangalore  
*Project No :* CNP 0125  
*Project duration :* 01/06/10 to 30/11/11  
*Project cost :* Rs. 7.18 lakhs

*Scientists/Technical officers involved:*

S Prabhakar (PL), G Bhaskar Raju (Co-PL), S Subba Rao, T V Vijayakumar,  
N Vasumathi

*Importance of contribution:*

Process, technological and engineering inputs in designing, fabrication, commissioning and stabilization of industrial flotation column was offered to M/s.Andhra Baryte Corporation Pvt Ltd. Chennai for the beneficiation of low-grade barytes of Mangampet, Kadapa, Andhra Pradesh.

**8. Consultancy services towards process optimization, stabilization and chemical reagents optimization during flotation process operations**

*Sponsor:* M/sJSW Steels Ltd, Vidya Nagar, Bellary District, Karnataka

*Project No :* CNP 0126

*Project duration :* 10/08/10 to 09/08/11

*Project cost :* Rs. 12.0 lakhs

*Scientists/Technical officers involved:*

S Prabhakar (PL), G Bhaskar Raju (Co-PL), S Subba Rao, T V Vijayakumar,  
N Vasumathi

*Importance of contribution:*

Assistance in stabilization of flotation process. Deliverables include: stabilization of flotation process, reagents preparation, optimization of process parameters, the operational performance of DEC with respect to flotation process parameters, shortcomings, if any, in flotation operation will be identified and brought to the notice of M/s JSW Steel Ltd., training of plant personnel on quality control for optimizing grade and recovery.

Reagent dosages have been optimised in the flotation process. Collector formulation has been modified to take care of over frothing within the process.

**9. Consultancy towards reagent evaluation for flotation of iron ores of JSW Ltd.**

*Sponsor:* M/s Somu Organo Chem P Ltd, Bangalore

*Project No :* CNP 0127

*Project duration :* 15/9/10 to 14/10/10

*Project cost :* Rs. 1.14 lakhs

*Scientists/Technical officers involved:*

S Prabhakar (PL), G Bhaskar Raju (Co-PL), S Subba Rao, T V Vijayakumar,  
N Vasumathi

*Importance of contribution:*

Evaluation of flotation properties of the reagent for the beneficiation of iron ores.

## 10. Studies on Skid Resistance and colour fading of cement tiles

*Sponsor:* M/s Ultra Tiles P Ltd., Chennai  
*Project No:* SSP 0608  
*Project duration:* 1/8/10 to 30/7/11  
*Project cost:* Rs.2 lakhs  
*Scientists/Technical officers involved:*  
A Rajakumar (PL)

### *Importance of contribution:*

The project involves characterization studies on cement tiles for their specific physical properties, such as skid resistance and colour fading of the tiles evaluated as per relevant standards.

## 11. Beneficiation studies of Coal (IX Seam) from Jamadoba

*Sponsor:* M/s Tata Steel, Jamshedpur  
*Project No :* CLP 0063  
*Project duration :* 1/9/10 to 31/5/11  
*Project cost :* Rs.12.12 lakhs

### *Scientists/Technical officers involved:*

S. Prabhakar (PL), G Bhaskar Raju (Co-PL), S Subba Rao, T V Vijayakumar, N Vasumathi

### *Importance of contribution:*

Objective of the project is to study the beneficiation characteristics of coal to achieve optimum yield. The deliverables are establishing the optimum process parameters for the beneficiation of seam IX coal, defining optimum yield at accepted ash content and evaluate the performance of flotation cell with spargers.

Washability, HMS cum liberation studies along with flotation were conducted to delineate flotation behaviour of seam IX coal vis-a-vis raw coal. Similar studies were carried out on seam VIII coal. Studies brought out the flotability nature of the these three types of coals.

## 12. Development of a reagent to replace Diesel in Coal Flotation

*Sponsor:* M/s Tata Steel, Jamshedpur  
*Project No :* CLP 0064  
*Project duration :* 1/9/10 to 31/8/11  
*Project cost :* Rs. 15.0 lakhs

### *Scientists/Technical officers involved:*

S. Prabhakar (PL), G Bhaskar Raju (Co-PL), S Subba Rao, T V Vijayakumar, N Vasumathi

### *Importance of contribution:*

Objectives of the project are to develop a single reagent system for the flotation of fine coal with high yield and low ash, evaluate the flotation properties of the reagent on coal from different seams and to replace the existing practice of using diesel and frother.

Laboratory flotation studies were conducted using various formulation of single reagents developed by M/s Somu and for comparison purpose tests were conducted with the two reagent system (diesel and frother) presently employed in the plant. Among the reagents SOKEM 590C was found effective. Short term plant trials were taken up and the results were found encouraging. Long term plant trials are planned.

### **13. Failure analysis of boiler bank tube (M/s HZL, Chittogarh, Rajasthan)**

*Sponsor:* M/s HZL, Chittorgarh, Rajasthan  
*Project No :* SSP 0612  
*Project duration :* 20/11/10 to 30/06/11  
*Project cost :* Rs. 1.0 lakh

*Scientists/Technical officers involved:*

M. Ananda Rao (PL), K. Gopala Krishna (Co-PL), R. Gopalakrishnan

*Importance of contribution:*

Carrying out failure analysis of the boiler tank tube involving visual examination, stereo microscopy, optical microscopy, evaluation of mechanical properties, deposit chemical analysis, scanning electron microscopy with EDX analysis.

Based on the evidences obtained and analysis of the present investigation it was concluded that the tube failed due to oxygen pitting and stress corrosion cracking.

### **14. Separation of lead from carbon sludge**

*Sponsor:* M/s TVS Harita NTI Ltd., Chennai  
*Project No:* SSP 0613  
*Project duration:* 3/1/11 to 30/3/11  
*Project cost:* Rs. 2 lakhs

*Scientists/Technical officers involved:*

G Bhaskar Raju, (PL) T V Vijayakumar (Co-PL), S Subba Rao, S Prabhakar, N. Vasumathi

*Importance of contribution*

M/s Haria-NTI Ltd., has installed an unique plant in Chennai to dispose waste plastic material which is non biodegradable into a mixture of gasoline, diesel and mid-distillates by using catalytic pyrolysis process. During the process of catalytic pyrolysis, black color sludge is formed as by product. Since the black color sludge is emanated from lead bath, the sludge is expected to contain Pb. M/s Harita-NTI approached National Metallurgical Laboratory – Madras Centre to suggest suitable flow sheet to separate lead from carbon sludge.

Flotation tests were conducted to separate lead from carbon. Complete separation of Pb from carbon was found not feasible. As flotation didn't respond, alternative chemical route is being explored where the results are found to be encouraging.



**B: Completed (13)**

**1. Evaluation of Reagents for flotation**

*Sponsor:* M/s Somu Organo Chem P Ltd., Bangalore  
*Project No :* SSP 0588  
*Project duration :* 1/4/10 to 31/3/11  
*Project cost :* Rs. 3 lakhs

*Scientists/Technical officers involved:*  
S Prabhakar (PL), G Bhaskar Raju (Co-PL), S Subba Rao, T V Vijayakumar, N Vasumathi

*Importance of contribution:*

Evaluation of flotation properties of the reagents supplied by the party. Some of the samples which were investigated were iron ore tailings, manfaniferrous clay, flue dust and limestone belonging to various industries.

**2. Installation of one set of PP spargers in flotation column**

*Sponsor:* M/s IREL, Chatrapur  
*Project No :* SSP 0609  
*Project duration :* 1/9/10 to 14/10/10  
*Project cost :* Rs. 75000

*Scientists/Technical officers involved:*  
S Prabhakar (PL), G Bhaskar Raju (Co-PL), S. Subba Rao, T V Vijayakumar

*Importance of contribution:*

Re-commissioning of polypropylene spargers in NML flotation column IREL's Mineral Separation Plant at Chatrapur, Orissa.

**3. Charaterization studies on granite samples**

*Sponsor:* M/s PRP Exports, Madurai  
*Project No :* SSP 0610  
*Project duration :* 7/9/10 to 31/3/11  
*Project cost :* 0.72 lakhs

*Scientists/Technical officers involved:*  
A Rajkumar (PL)

*Importance of contribution:*

The objective of the project is to evaluation granite samples by carrying out their physical properties viz., absorption, specific gravity, flexural strength, modulus of rupture, abrasion resistance and coefficient of friction. The services are widely used by to enhance the scope for effective marketability and thus generating constant revenue to the organization.

#### **4. Studies on skid resistance and color fading of cement tiles**

*Sponsor:* Ultra Tiles (P) Ltd., Chennai  
*Project No :* SSP 0516  
*Project duration :* 1/8/09 to 31/7/10  
*Project cost :* Rs. 2.20 lakhs

*Scientists/Technical officers involved:*  
A. Rajakumar (PL)

##### **Importance of contribution**

The project involves characterization studies on cement tiles for their specific physical properties, such as skid resistance and colour fading of the tiles evaluated as per relevant standards.

#### **5. Verification of hardness testing machines**

*Sponsor:* Fine Manufacturing Industries, Miraj  
*Project No :* SSP 0522  
*Project duration:* 11/7/09 to 11/7/10  
*Project cost :* Rs.55,510

*Scientists/Technical officers involved:*  
R. Gopala Krishnan (PL) and S. Subba Rao (Co-PL)

##### **Importance of contribution**

Verification of party's hardness testing machines for their suitability to calibrate the standard test blocks manufactured by them. Carry out onsite inspection of hardness test machines using certified reference materials having national/international traceability. Verification of machines was carried out at Customers site on August 2009 and the following machines were checked and verified.

#### **6. Failure analysis of boiler water tube in the power plant**

*Sponsor:* Ind-Barath Powergencom Ltd., Chennai  
*Project No :* SSP 0538  
*Project duration:* 22/10/09 to 30/04/10  
*Project cost :* Rs.1.60 lakhs

*Scientists/Technical officers involved:*  
M. Ananda Rao (PL), Sapan K Das (Co-PL) Satendra Kumar, V. Rajnikanth,  
K. Gopala Krishna & R. Gopalakrishnan

##### **Importance of contribution**

To ascertain the cause of failure and suggest methods to avoid similar occurrences. Visual examination, stereo microscopy, optical microscopy, evolution of mechanical properties, chemical analysis, fractography studies, scanning electron microscopy with EDX analysis were carried out.

Based on the evidences provided and the analysis conducted the cause of failure was due to short term over heating along with the other failure mechanisms on fire side (hot salt corrosion) and water side (oxygen pitting) surface of the tubes.

## **7. Studies on Cement Tiles**

*Sponsor:* Ultra Tiles (P) Ltd., Chennai  
*Project No :* SSP 0540  
*Project duration:* 7/11/09 to 6/11/10  
*Project cost :* Rs.2.20 lakhs

*Scientists/Technical officers involved:*  
A. Rajakumar (PL)

### **Importance of contribution**

Conformance of physical properties of cement tiles to IS 1237:1980 will be tested. Tests will be conducted for abrasion/wear resistance, water absorption, flexural/wet transverse strength & flatness (concavity and convexity).

## **8. Evaluation of the chemical composition of steel samples for conforming to IS 204:1994 and EN8 specifications**

*Sponsor:* IIT Madras, Chennai  
*Project No :* SSP 0579  
*Project duration:* 9/12/09 to 31/5/10  
*Project cost :* Rs.55,150

*Scientists/Technical officers involved:*  
TSN Sankara Narayanan (PL), Satendra Kumar (Co-PL)

### **Importance of contribution**

Chemical analysis will be carried out to ascertain whether the samples conform to the chemical requirement of Class IV of IS 2004:1994 and EN8 specifications. Scope: Chemical Analysis by OES

## **9. Expert opinion on evaluation and classification of non-alloy steel bars, slabs and re-rollable scrap**

*Sponsor:* Sabari Exim (P) Ltd., Chennai  
*Project No :* SSP 0582  
*Project duration:* 04/2/10 to 03/8/10  
*Project cost:* Rs.89,343

*Scientists/Technical officers involved:*  
K Gopala Krishna (PL), R. Gopalakrishnan (Co-PL), M. Ananda Rao,  
TSN Sankara Narayanan & Satendra Kumar

### **Importance of contribution**

Expert opinion will be provided to Dept. Of Customs. Inspection of consignments at Customs yard, chemical analysis of the drawn samples and formation of technical opinion on the classification of consignment.

#### 10. **Failure analysis of economizer tube**

*Sponsor:* Hindustan Zinc Ltd., Chittorgarh Dist.  
*Project No :* SSP 0589  
*Project duration:* 19/04/10 to 18/10/10  
*Project cost:* Rs. 1.4 lakhs

*Scientists/Technical officers involved:*  
M Ananda Rao (PL), M K Gunjan (Co-PL), K Gopalakrishna, Satendra Kumar

##### **Importance of contribution**

To ascertain the cause of failure and suggest methods to avoid such occurrences. The scope of work includes, visual examination, stereo microscopy, optical microscopy evaluation of mechanical properties, chemical analysis, fractography studies, scanning electron microscopy with EDX analysis.

Based on the evidences obtained in the present investigation it was concluded that the failure occurred due to hot salt corrosion and along with simultaneous action of erosion mechanism.

#### 11. **Reduction of iron contamination in quartz**

*Sponsor:* GET Minerals and Coal Pvt. Ltd., Chennai  
*Project No :* SSP 0593  
*Project duration:* 14/05/10 to 13/09/10  
*Project cost:* Rs.2.5 lakhs

*Scientists/Technical officers involved:*  
T V Vijaya Kumar (PL), S Subba Rao (Co-PL), S Prabhakar, G Bhaskar Raju and N. Vasumathi

##### **Importance of contribution**

The objective of the project is to improve silica quality by reducing iron contamination in quartz sample. The scope is sample characterization, crushing and grinding, scrubbing and development of flow sheet. Attrition scrubbing was used to reduce surface contamination of the quartz grains supported by environmental friendly, biodegradable natural substances. Multiple stages of scrubbing (2 or 3) are required for reduction of surface contamination. The specifications for flat glass are SiO<sub>2</sub>: 99.5%, Fe<sub>2</sub>O<sub>3</sub>: 0.04% max., Al<sub>2</sub>O<sub>3</sub>: 0.30% max. The analyses of the products generated in the present study closely match with the above mentioned specifications. Further improvement in quality appears to have been limited by the factors such as structural and mineralogical imperfections of quartz grains.

#### 12. **Evaluation of the characteristics of powder samples**

*Sponsor:* The Appraiser, Office of Commissioner of Customs, Bangalore  
*Project No :* SSP 0595  
*Project duration:* 21/05/10 to 20/11/10  
*Project cost:* Rs. 0.5 lakhs

*Scientists/Technical officers involved:*

TSN Sankara Narayanan (PL), Satendra Kumar (Co-PL)

***Importance of contribution***

To evaluate the physical properties and chemical composition of the powder samples. The study enabled classification of the powder samples based on their physical properties, chemical properties and X ray diffraction analysis. The results are much useful for the department of customs to confirm the materials imported as per declaration and to fix the duty for the consignment.

**13. Calibration of thermocouples**

*Sponsor:* Heatcon Sensors (P) Ltd., Bangalore

*Project No :* SSP 0604

*Project duration:* 21/05/10 to 20/09/10

*Project cost:* Rs.1.29 lakhs

*Scientists/Technical officers involved:*

N N Bokade (PL), S. Subba Rao (Co-PL)

***Importance of contribution***

To check the performance of thermocouples/RTDs confirming their standard deviation in the range of accepted level of standard deviation traceable to National Standards.

Type of sensors calibrated: K type (Range 200 to 1100 deg. C) and J type (100 to 650 deg. C).

• **Exploratory Research Projects (OLP)**

**Completed projects: (1)**

***Evaluation of the fretting corrosion behaviour of surface modified CP-Ti for biomedical applications***

*Project No :* OLP-0126

*Project duration :* 3/8/09 to 2/8/10

*Scientists/Technical officers involved:*

Dr. TSN Sankara Narayanan (PL), Satendra Kumar (Co-PL)

***Importance of contribution***

The objective of this project is to evaluate the fretting corrosion behaviour of surface modified CP-Ti in Ringer's solution to assess their suitability for implant applications.

Significant achievements of the project are:

- An understanding of the fretting corrosion behaviour of surface modified CP-Ti in Ringer's solution.
- The major limitation of surface modified CP-Ti is identified
- The importance of fracture toughness of coatings, galvanic coupling are addressed for the first time.

- ◆ *Basic or Applied Research Projects:* (covered under exploratory projects)
- ◆ **Technical assistance provided to industries (completed as well as ongoing)**
- i) **Technical opinion on classification of imported metallurgical consignments**

*Scientists/Technical Officers involved:*

R. Gopalakrishnan, K. Gopalakrishna, M. Ananda Rao

Importance of contribution:

The Centre is involved in consultancy services to the Department of Customs, Chennai, Tuticorin, Mumbai and Visakhapatnam etc, Directorate of Revenue and Intelligence of Chennai in giving technical opinion on import/export of metallic consignments for evaluation of grade and appropriate classification. The activity involves visit of scientists to various container freight stations (CFS), visual examination of the materials, drawing representative samples for testing and carrying out necessary chemical and metallurgical tests. Results are compiled and detailed reports are submitted taking into consideration various standards and industrial practices.

In addition to serving the Govt. Departments for their decision making, the activity contributed significantly to the Centre's ECF generation.

ii) **Calibration of Thermocouples/devices/sensors**

Scientific/Technical Officers involved:

G. Jeevanandam

*Importance of contribution:*

Temperature calibration section offered testing and calibration of various types of thermocouples of Type: B, R, S, J, K and T with temperature ranging from 0 to 1500°C and also platinum and other resistance thermometers from 0 to 600 °C. The Centre also calibrated furnaces, ovens and other temperature devices, and instruments such as temperature controller/indicators, millivolt, resistance indicators and simulators.

The Centre has the state-of-the-art equipment for providing the above services traceable to national and international standards. Also services were provided for on-site calibration as and when required by the customers. The Centre catered to a wide range of customers from major user industries to small-scale manufacturers of thermocouples and RTD's.

iii) **Metallurgical characterisation**

*Scientists/Technical Officers involved:*

R.Gopalakrishnan, K.Gopalakrishna, M. Ananda Rao

*Importance of contribution:*

The metallurgical section provided services in characterisation of metallic samples, and micro-macro hardness testing.

**iv) Chemical Analysis of metals and alloys**

*Scientific/Technical Officers involved:*

TSN Sankara Narayanan

*Importance of contribution:*

The Chemistry group offered services for chemical analysis of metals and alloys, ores and ceramics. The Centre has state-of-the-art equipment for providing the above services apart from conventional wet chemical analysis. The Centre provided technical opinion based on chemical analysis traceable to national and international standards. Besides Department of Customs and Bureau of Indian Standards, the Centre provided services to a wide range of customers from major user industries to small-scale manufacturers.

**v) Tiles Testing**

*Scientific/Technical Officers involved:*

A. Rajakumar

*Importance of contribution:*

The tiles testing group offered services for carrying out various tests for estimating different properties of finished tiles. The tests included estimation of compressive strength, flexural strength, water absorption, flatness (concavity and convexity),

**vi) Fine particle characterization**

*Scientists/Technical Officers involved:*

N. Vasumathi, T V Vijayakumar, K. Chennakesavulu

*Importance of contribution:*

The Centre has established excellent facilities in fine particle characterization in air and liquid suspensions (aqueous and organic). The characterization methods include particle size measurement, surface area measurement, surface energy measurement, density measurements, zeta potential measurements in dense slurries and suspensions and rheology measurements. Available facilities include laser diffraction analyzer (CILAS), BET (Micromeritics), Tensioneter (Kruss), Rheometer (Anton Paar), Zetasizer based on acoustic attenuation (Dispersion Technologies) and Pycnometer (Micromeritics). This service is expected to be useful to drug & pharmaceutical industries, chemical industries, cosmetic industries, ceramic industries and mineral industries.

**4. Reports on support services (within 300-400 words) pertaining to supporting and infrastructural divisions (LTU/Intellectual property management/Techno economics and Technical Auditing /Technology Marketing/Planning/Lib. Documentation/Publications & Information Dissemination/Instrumentation & Electrical Services (R&D)/Engineering (Civil and Maintenance)**

- NIL -

**5. Papers published with full bibliographical details (i.e., the authors, year, journal, volume, pages etc. along with the abstract of the paper).**

**A. Papers published in SCI journal (14)**

1. Balumsamy, T, Satendra Kumar, T S N Sankaranarayanan  
Effect of surface nanocrystallization on the corrosion behaviour of AISI 409 stainless steel  
Corrosion Science, 52 (2010), 11, 3826-3834. (Impact Factor: 2.316)
2. Satendra Kumar, T.S.N. Sankara Narayanan, S. Ganesh Sundara Raman and S.K. Seshadri,  
Surface modification of CP-Ti to improve the fretting corrosion resistance: Thermal oxidation vs. anodizing,  
Materials Science and Engineering C-Materials for Biological Applications, 30 (2010), 6, 921- 927. (Impact Factor: 1.842)
3. Satendra Kumar, T.S.N. Sankara Narayanan, S. Ganesh Sundara Raman,  
Thermal oxidation of CP-Ti - An electrochemical and structural characterization,  
Materials Characterization, 61 (2010), 6, 589-597. (Impact Factor: 1.416)
4. Satendra Kumar, T.S.N. Sankara Narayanan, S.Ganesh Sundara Raman & S.K. Seshadri,  
Evaluation of fretting corrosion behaviour of CP-Ti for orthopaedic implant applications  
Tribology International, 43 (2010), 7, 1245-1252. (Impact Factor:1.690)
5. Satendra Kumar, B. Sivakumar, T.S.N. Sankara Narayanan, S. Ganesh Sundara Raman and S.K. Seshadri,  
Fretting corrosion mapping of CP-Ti in Ringer's solution,  
Wear, 268 (2010), 1537-1541. (Impact Factor: 1.771)
6. Satendra Kumar, T S N Sankara Narayanan, S. Ganesh Sundara Raman and S. K. Seshadri  
Thermal oxidation of CP-Ti: Evaluation of characteristics and corrosion resistance as a function of treatment time  
Materials Science & Engineering C – Materials for Biological Applications, 30 (2010), 2, 330 (Impact Factor: 1.842)
7. K. Chennakesavulu, G. Bhaskar Raju and S. Prabhakar,  
Studies on the adsorption of arsenic on calix[6]arene  
Jl. Of Physical and Organic Chemistry, 23 (2010), 723-729 (Impact Factor: 1.602)
8. P Lakshmipathiraj, S. Prabhakar, G Bhaskar Raju  
Studies on the electrochemical decontamination of wastewater containing arsenic  
Separation and Purification Technology 73 (2010), 114-121 (Impact Factor: 2.879)
9. T V Vijaya Kumar, D S Rao, S.Subba Rao, S. Prabhakar, and G Bhaskar Raju  
Reverse flotation studies on an Indian low-grade iron ore slimes  
International Journal of Engineering Science and Technology, 2, no.4 (2010) 637-648. (Impact Factor: 0.931)
10. M.Murugananthan, S.S.Latha, G.Bhaskar Raju and S.Yoshihara  
Anodic oxidation of ketofrofen-an anti-inflammatory drug using boron doped diamond electrode  
J. Hazard. Mater, 180 (2010) 753-758. (Impact Factor: 4.144)



11. Danda S Rao, Tadiparthi V Vijaya Kumar, Shivakumar Angadi, Swarna Prabhakar, and Guntamadugu B Raju  
Effect of modulus and dosage of sodium silicate on limestone flotation  
Maejo.Int.J.Sci.Technol. 2010, 4(03), 397-404. (Impact Factor: 0.222)
12. K.Chennakesavulu, M.Raviathul Basaria, G.Bhaskar Raju, S.Prabhakar  
Study on thermal decomposition of calyx[6]arene and calyx[8]arene  
J. Therm Anal Calorim, 103 (2011) 853-862. (Impact Factor: 1.587)
13. K.Chennakesavulu, M.Raviathul Basaria, P.Sreedevi, G.Bhaskar Raju, S.Prabhakar, S.Subba Rao,  
Study on thermal decomposition of calyx[4]arene and its application in thermal stability of polypropylene  
Thermochimica Acta, 515 (2011) 24-31. (Impact Factor: 1.742)
14. D. S. Rao, T. V. VijayaKumar, S. Prabhakar, G. Bhaskar Raju,  
Geochemical assessment of a siliceous limestone sample for cement making  
Chin. J. Geochem, 30 (2011) 33-39. (Impact Factor: 1.17)

**B. Publications in Press: SCI – (4)**

1. G.Bhaskar Raju, Ramachandra Keerthi, S.S.Latha, S.Prabhakar  
Degradation of dyes by UV/O<sub>3</sub>/H<sub>2</sub>O<sub>2</sub> and electrooxidation techniques  
Water Practice and Technology (In press)
2. M.Murugananthan, S.S.Latha, G.Bhaskar Raju and S.Yoshihara, Role of electrolyte on anodic mineralization of atenolol at boron doped diamond and Pt electrodes  
Separation and Purification Technology (In press)
3. D. S. Rao, T. V. VijayaKumar, S.Subba Rao, S.Prabhakar, G. Bhaskar Raju  
Column flotation studies on the utilization of siliceous limestone for cement making  
J Min Meta and Met (In press)
4. K. Gopala Krishna, Nidhi Singh, K. Venkateswarlu and K. C. Hari Kumar  
Tensile behaviour of ultrafine-grained Al-4Zn-2Mg alloy produced by cryorolling  
Jl. Of Materials Engineering and Performance (In press)

**C: Publications in Non-SCI journals (2)**

1. T.V. Vijaya Kumar, D.S. Rao, S.Subba Rao, S. Prabhakar, G. Bhaskar Raju,  
Cleaner production of garnet sand for environmental abatement  
The Pacific Journal of Science and Technology, Vol 11 (2) 2010, 585-591.
2. G.Bhaskar Raju, D. Latha Priya, S.S.Latha, Parvathy and S.Prabhakar  
Removal of organics from the waste waters of dye bath by electro oxidation  
Asian Journal of Water, Environment and Pollution, Vol.7 (4) (2010) 19-23.

**D. Chapter in a book:**

1. M.Murugananthan, and G.Bhaskar Raju  
Removal of organic dyes and tannins by electrochemical techniques  
Photo-electrochemistry & photobiology for the sustainability, Editors: S.Kaneco, B.Viswanathan, H.Katsumata, Chapter 8, 2010, 1, 189-215.
2. T.S.N. Sankara Narayanan, Nanomaterials and Tribocorrosion, Corrosion Protection and Control Using Nanomaterials, Viswanathan S. Saji and Ronald Cook (Eds.), Woodhead Publishing Limited, Cambridge, UK.

**(In Press)**

3. T.S.N. Sankara Narayanan and S.K. Seshadri, Electro- and electroless composite coatings, Encyclopaedia of Tribology, George E. Totten (Section Editor: Surface engineering: treatments), Q. Jane Wang and Yip Wah Chung (Editors-in-Chief), Springer-Verlag GmbH, Heidelberg (*in press*)
4. Dr. TSN Sankara Narayanan, Contributed a review paper on *Advances in Surface Treatment and Electrodeposition* for the special issue of International Journal of Corrosion Reviews on *Corrosion Science and Technology in India*, Edited by Dr. Baldev Raj and U. Kamachi Mudali (*in press*)
5. M. Murugananthan, G Bhaskar Raju, S. Yoshihara, Treatment of pharmaceutical compounds by electro-oxidation using boron doped diamond and platinum anodes, in the book Hazardous Materials : Types, risks and control; Publisher Nova Science Publishers (*In press*)

**4. Symposia/seminars attended (name of the symposia/seminars, sponsoring/organizing authority, venue, date & details of papers presented-**

- Dr. TSN Sankaranarayanan and Mr. K Gopala Krishna, Scientists, have attended the 15<sup>th</sup> National Congress on Corrosion Control organized by National Corrosion Council of India at Chennai during Sept. 16-18, 2010.
- Mr. T. Balusamy, Proj. Asst. has attended a National Workshop on Nanomaterials and its Applications (NANOMAT 2010), held at Dept.f of Manufacturing Engineering, Anna University, Chennai during Sept. 20-21, 2010.
- Dr. TSN Sankaranarayanan, Scientist, has attended the Indo-Austrian Symposium on Advanced Materials Engineering, held at NFTDC, Hyderabad, during Dec. 8-9, 2010.
- Mr. T Balusamy, Proj. Asst., has attended the International Conference in Nanomaterials and Nanotechnology (NANO 2010) held at KSR College of Technology, Tiruchengode during 13-16, Dec., 2010.
- Dr. G Bhaskar Raju, Dr. S Prabhakar, Dr. S Subba Rao, Mr. T V Vijayakumar, Scientists, have attended the XI International Seminar on Mineral Processing Technology (MPT 2010) held at NML, Jamshedpur during 15-17, Dec., 2010. Mr. Vijayakumar has presented the paper on 'Quality improvement of garnet and quartz by environment friendly natural surfactant'.

- Mr. T. Balusamy, Proj. Asst. has attended the International Symposium for Research Scholars on Metallurgy, held at IIT Madras during Dec. 20-22, 2010.
  - Mr. K. Chennakesavulu, SRF, presented a poster titled “Study on thermal decomposition of calix[n]arenes” in “12<sup>th</sup>, CRSI National Symposium in Chemistry”, during 5-7<sup>th</sup> February, 2010 organized by Indian Institute of Chemical Technology, Hyderabad, Andhra Pradesh, India.
  - Mr. K. Chennakesavulu, SRF, presented a paper titled “Thermal decomposition of Calix[n]arenes and their applications” in “Young Chem 2010” during 6-10<sup>th</sup>, October, 2010, held at Reda, Poland.
  - Mr. K. Chennakesavulu, SRF, presented a paper titled “Calix[n]arenes and their applications” in “Chennai Chemistry Conference” during 11-13<sup>th</sup>, February, 2011, held at Department of Chemistry, IIT Madras, Chennai, Tamilnadu, India.
  - Mr. K. Chennakesavulu, SRF, presented a paper titled “The interaction of arsenic compounds with calix[6]arene” in International Conference in Supramolecular Chemistry and Nanomaterials – 2011 during 14-16<sup>th</sup>, February, 2011, held at Department of Chemistry, University of Mumbai, Mumbai, India.
7. **Patents filed/accepted/sealed indicating the title of the patent, inventors and date of filing/acceptance/sealing (Patent Application No.):**

**NIL**

**8. External Cash flow: Project name, amount contracted, amount received etc. 2010-11****8.A Income from Projects:**

| Proj. No. | Title   | Sponsor                                   | Project cost | Amt recd | Remarks                              |
|-----------|---|---|--------------|----------|--------------------------------------|
| SSP-0588  | Evaluation of Reagents for flotation  | Somu Organo Chemi P Ltd Bangalore         | 300000       | 300000   | Full and final payment               |
| SSP-0593  | Reduction of iron contamination in quartz   | GET Minerals and Coal Pvt Ltd., Chennai   | 250000       | 222425   | Full and final payment               |
| SSP-0369  | Design, formulation of specification, supervision of installation and commissioning of column flotation for 6 tph capacity for Sillimanite  | IRE, Chavara                              | 1023750      | 197234   | 3 <sup>rd</sup> and final payment    |
| CNP-0125  | 2.5 metre dia Industrial Plant Flotation column to M/s Andhra Barites Corporation Ltd (ABCL) supplied by M/s McNally Bharat Engineering Company (MBE) under the scope of the agreement between NML and MBE to market the column flotation technology. | McNally Sayajee Bangalore                 | 717750       | 638582   | First and final payment              |
| CLP-0063  | Beneficiation studies of Coal (IX Seam) from Jamadoba   | Tata Steel, Jamshedpur                    | 1099000      | 400000   | Two part payment                     |
| CLP-0064  | Development of a reagent to replace Diesel in Coal Flotation  | Tata Steel, Jamshedpur                    | 1500000      | 600000   | Two part payment                     |
| SSP-0609  | Installation of one set of (PP) spargers in flotation column  | IRE, Chatrapur                            | 75000        | 66728    | Full payment                         |
| CNP-0127  | Consultancy services for improvement of the reagents leading to commercialization of the flotation reagents   | Somu Organo Chem (P) Ltd., Bangalore      |              | 114234   |                                      |
| CNP-0126  | Consultancy related to flotation process operations at JSW Steels New Flotation Plant   | JSW Steel Ltd., Bellary Dist.             | 120000       | 967942   | Major payment                        |
| SSP-0613  | Separation of lead from carbon sludge   | HARITA NTI Ltd                            | 200000       | 177940   | Full & final                         |
| SSP-0668  | Failure analysis of rollers   | Oriental Insurance Co. Ltd Chennai        | 300000       | 300000   | First and final                      |
| SSP-0615  | Purification of wastewater from ossein production plant by electrocoagulation   | Pioneer Jellice India Pvt Ltd., Cuddalore | 100000       | 100000   | First and final                      |
| SSP-0586  | Characterization studies on Rubber Tiles  | Ultra Tiles P Ltd., Chennai               | 600000       | 300000   | 50% paid in two instalments          |
| SSP-0540  | Studies on cement tiles   | Ultra Tiles P Ltd., Chennai               | 200000       | 100000   | 2 <sup>nd</sup> and final instalment |
| SSP-0608  | Studies on Skid Resistance and Colour Fading of Tiles   | Ultra Tiles P Ltd., Chennai               | 200000       | 200000   | Full payment in 2 instalments        |
| SSP-0610  | Characterization studies on Granite samples   | P R P Exports, Madurai                    | 65000        | 65000    | Full payment                         |
| SSP-0614  | Studies on Cement Tiles   | Ultra Tiles P Ltd                         | 200000       | 200000   | Full payment                         |
| SSP-0592  | Evaluation of corrosion performance of reinforcement steel  | N.R.Patel & Co., Chennai                  | 100000       | 88970    | Full and final payment               |
| SSP-0603  | Chemical analysis of steel billet samples   | Sumangala Steels P Ltd., Chennai          | 164000       | 145911   | Full and final payment               |
| SSP-0595  | Evaluation of the characteristics of powder samples   | Customs Department Bangalore.             | 50000        | 50000    | Full and final payment               |
| SSP-0589  | Failure analysis of economizer tube   | Hindustan Zinc Ltd., Chittorgarh          | 140000       | 125598   | Full payment in 2 instalments        |

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|                                     |   |                                  |        |                |                               |
|-------------------------------------|---|----------------------------------|--------|----------------|-------------------------------|
| SSP-0612                            | Failure analysis of boiler bank tube at HZL, Chittorgarh                      | Hindustan Zinc Ltd., Chittorgarh | 100000 | 88970          | Full payment in 2 instalments |
| SSP-0611                            | Expert opinion on evaluation and classification of MS Re-rollable Steel Scrap | Galaxy Commercial, Chennai       | 144000 | 144000         | Full payment                  |
| SSP-0604                            | Calibration of thermocouples  | Heatcon Labs, Bangalore          | 128750 | 128750         | Full and final payment        |
| <b>Sub-total from projects (8A)</b> |   |                                  |        | <b>5722284</b> |                               |

8. A Income from Projects (Section wise):

| Description              | Amount, in Rs.   |
|--------------------------|------------------|
| Mineral Processing       | 37,85,085        |
| Metallurgy               | 6,58,568         |
| Chemistry                | 2,84,881         |
| Tiles testing            | 8,65,000         |
| Thermocouple Calibration | 1,28,750         |
| <b>Sub-Total (8 A)</b>   | <b>57,22,284</b> |

8. B Income from calibration, testing, analysis and expert opinion services

| Description   | Amount, in Rs.   |
|---|------------------|
| Chemical Analysis (OES, AAS and conventional analysis)                          | 4,72,761         |
| Metallurgical testing and expert opinion on imported metallurgical consignments | 18,08,286        |
| Tiles testing   | 99,000           |
| Temperature Calibration (Thermocouples and RTDs)                                | 4,30,899         |
| Instrumental Analysis (Particle size, BET, Viscosity)                           | 1,61,139         |
| <b>Sub-Total (8 B)</b>  | <b>29,72,085</b> |

**Total income (ECF)**

|   |                  |
|---|------------------|
| Income from projects (8A)   | 57,22,284        |
| Income from calibration, testing, analysis and expert opinion services (8B) | 29,72,085        |
| <b>TOTAL INCOME (ECF)</b>   | <b>86,94,369</b> |

**9. Seminars/Symposia/Workshop organized—if any furnish information with a brief write-up**

- Dr. N. Krishnaraj, Consultant – Metallurgist, Chennai gave a talk on Failure Analysis of Industrial Components, on 1 June, 2010

**10. Colloquia/Talks Delivered – Name of the speaker/topic/date & venue/sponsor**

- Dr. S. Prabhakar has delivered a talk on 'Beneficiation studies of iron ore fines by Column flotation' at SAIL, Kolkata on 17<sup>th</sup> March, 2011
- Dr. S. Prabhakar has delivered an invited talk on 'Column flotation for beneficiation of iron ore fines' at STEEL RISE, Tata Steel, Jamshedpur, 1-2, Feb., 2011.
- Dr. S. Prabhakar has delivered a key note address on 'Column flotation experience at NML' at International Conference on Mineral Processing Technology (MPT 2010), jointly organised by IIME & NML at Jamshedpur during 15-17 Dec., 2010.
- M. Ananda Rao, Scientist, has delivered a talk on 'Metallurgical failures in coal based thermal power plants', at Hindustan Zinc Ltd., Chittorgarh, Udaipur, August, 2010.

**11. New facilities developed, if any giving the technical write-up including a photograph, and its utility/benefit to client/users**

1. Standard Pt Resistance Thermometer, ISOTECH, UK, Model 670 SQ/25 Ω (2 nos.)

**12. Honours/Awards/Recognition/Nomination, if any giving details including the citation wherever applicable:**

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**13. Deputation, if any, giving detail—place of visit and duration / Name of the Programme/benefits accrued/Future Plan.**

Mr. K. Chennakesavulu, SRF, visited Warsaw University of Technology and Chemical Scientific Society "Flogiston", Poland to participate in conference Young Chem 2010 and gave an oral presentation under the title: Studies on thermal decomposition of calix[N]arenes during 2– 15 October, 2010.

**14. Training undertaken and training imparted/organized:**

**A: Training undertaken:**

Ms. N. Vasumathi, Scientist, has undertaken the Induction Training Programme organised by Human Resource Development Centre, CSIR, at HRDC, Ghaziabad during 7-17 March, 2011.

**B: Training imparted/organized:**

*Diamond Jubilee Research Interns*

The following Diamond Jubilee research interns are associated in ongoing projects in various sections:

- K. Sreedevi  
Evaluation of reagents for flotation
- Rajesh  
Hardness testing and microstructural characterization
- Mazhil Maran  
Modelling of column flotation process

Completed term during the year 2010-11

- B. Sivakumar  
Behavior of fretting corrosion of titanium alloys by electrochemical methods
- M. Jamesh  
Evaluation of corrosion behaviour titanium and its alloys by electrochemical method for implant purpose
- T. Balusamy  
Surface nano-crystallization of carbon steel and stainless steel by using surface mechanical attrition treatment (under SUPRA Project – SIP 0025)

Undergraduate engineering students from BITS, Pilani underwent PS- I training (22 May to 15 July, 2010) and completed their projects.

- Recent studies on production of ultrafine grain/nano grain materials using severe plastic deformation technique  
(R. Vikram & R. Vasanth)  
Supervisor: K. Gopalakrishna
- Development of Lab Instruments Management Software for NML  
(M V Trived)  
Supervisor: S Subba Rao
- Removal of iron oxide impurities from quartz by attrition scrubbing  
(Nipun Chaurasia)  
Supervisor: T V Vijayakumar

**15. Academic achievements – Ph.D awarded / M.Tech / M.Sc.—any other degree/diploma (names/topics/Institute/Year)**

- Mr. Satendra Kumar was awarded M.S. (by research) for his thesis entitled “Corrosion and Fretting Corrosion Behaviour of Surface Modified Ti and Ti-6Al-4V in Simulated Body Fluid” by the Department of Metallurgical and Materials Engineering, IIT Madras, Chennai in June, 2010.
- Mr. P. Lakshmipathiraj, SRF, has submitted his PhD thesis entitled ‘Studies on decontamination of aqueous solution containing arsenic and chromium by adsorption and electrochemical techniques’ under the supervision of Dr. S. Prabhakar, Scientist, to University of Madras, July 2010.

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**16. Name of Scientific/Technical/Administrative Staff** – (pre-revised) Scale of Rs.2000-3500 and above attached to each division/section with their designations, qualifications and professional/academic memberships, area of specialization).

| S. No                    | Name and Designation                       | Qualification   | Professional academic membership                 | Area of Specialization   |
|--------------------------|--|---|--|--|
| <b>Scientific staff:</b> |  |   |  |  |
| 1                        | Dr. G. Bhaskar Raju<br>Sct.G               | M.Sc. Ph.D  | Life Member<br>I.I.M.E., F.I.C.,<br>Fellow SAEST | Mineral Processing   |
| 2                        | Dr. S. Prabhakar<br>Sct.G                  | M.Sc., Ph.D   | Life Member<br>I.I.M.E., F.I.C.,                 | Mineral Processing   |
| 3                        | Dr. S. Subba Rao<br>Sct. F                 | Ph.D.(Chem. Engg)   | Life Member IIME<br>Life Member IChE             | Mineral Processing<br>QMS  |
| 4                        | Dr. T.S.N. Sankara<br>Narayanan, Sct. EI   | M.Sc. Ph.D.   | Fellow SAEST,<br>Fellow ECSI,<br>Member NACE     | Surface Engineering<br>Corrosion<br>Tribocorrosion<br>Chemical Analysis  |
| 5                        | Mr. K. Gopala Krishna<br>Sct.EI            | B.E.(Met),<br>M.S. (Information<br>Technology)<br>PG Diploma in TQM | Member IIM<br>Member WSI                         | Powder Metallurgy,<br>Surface Engineering &<br>Materials Characterization<br>Metallurgical Inspection,<br>Failure analysis |
| 6                        | Mr. T.V. Vijaya Kumar<br>Sct. EI           | M.A.Sc.<br>M.Sc. (Engg.)  | Life Member IIME,<br>Member IIM                  | Mineral Processing   |
| 7                        | Mr. M. Ananda Rao<br>Sct. C                | M. Tech.<br>(Metallurgy)  | --   | Metallurgy   |
| 8                        | N. Vasumathi<br>Sct. B                     | M.Tech. (Materials<br>Engg)   | Member IIME                                      | Material Science   |
| <b>Technical staff:</b>  |  |   |  |  |
| 9                        | Mr. R. Gopalakrishnan<br>Tech. Officer-EII | B.Sc., AMIE   | Fellow SAEST<br>Member IIE                       | Chemical Analysis,<br>Metallography, Failure<br>Analysis, Metallurgical<br>Inspection                                      |
| 10                       | Mr. A. Rajakumar<br>Tech. Officer- EI      | M.Sc., (Geology)  | Fellow MS  | Mineral Processing and<br>Tiles Testing  |
| 11                       | Mr. Naresh N. Bokade*<br>Tech. Officer – C | M.Tech.<br>(Electronics)  | --   | Thermocouple calibration<br>Embedded systems<br>Electronics<br>Instrumentation   |
| 12                       | Mr. Satendra Kumar, JTA**                  | B.E. (Metallurgy)   | Member IIM                                       | Chemical Analysis  |

\* Transferred to NEERI Nagpur

\*\* Resigned



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| <b>Supporting &amp; Administrative staff:</b> |                                   |   |   |
|---|-----------------------------------|---|---|
| 13  | Mr. A. Ramesh<br>Asst. (F&A)      | M.Com., MBA   | Accountancy, Materials<br>management          |
| 14  | Mr. S. Sankar<br>Senior Steno     | S.S.L.C.  | Secretarial assistance                        |
| 15  | Mr. G. Jeevanandam<br>Technician  | ITI (Machinist)   | Thermocouple calibration                      |
| 16  | Mr. A. Raj<br>Technician          | Dip. In Mechanical  | Metallurgical<br>Characterisation             |
| 17  | Mr. T. Tirupati Rao<br>Technician | Dip. In AUTOCAD<br>CTI (Draughtsman- Mech.)<br>M.A. (History) | Assistance to all sections<br>and Secretariat |
| 18  | Mr. V. Vaidyanathan<br>Technician | B.Com   | -do-  |
| <b>Research staff:</b>                        |                                   |   |   |
| 1   | Dr. M. Muruganathan, QHF          | PhD (Chemistry)   | Mineral Processing                            |
| 2   | K. Chennakesavulu, SRF            | M.Sc. (Chemistry)   | Mineral Processing                            |
| 3   | M. Raviathul Basariya, SRF        | M.Sc. (Materials Science)                                     | Metallurgy                                    |

**17. Any other information that the project coordinators / project leaders/ Heads of Divisions/ Sections think necessary for inclusion in the report like special services rendered etc. which may serve to the cause of the industrial / regional development.**

- ISO 9001:2008 re-certifying audit of the Centre was conducted in May, 2010
- NML Madras Centre participated at the CSIR Techno-Fest held during Nov. 14-27 at Pragati Maidan, New Delhi and showcased the technologies developed at the Centre. The theme pavilion of Metals, Minerals and Materials which NML participated has won an Award in the category of industrial partners.
- Dr. G. Bhaskar Raju, Dr. S. Prabhakar, Dr. T.S.N. Sankara Narayanan served as reviewers for several papers in many international journals including J. Electrochemical Society, Metallurgical Transactions, Surface and Coatings Technology, J. Hazardous Materials, Hydrometallurgy, J Materials Science and Indian Journal of Marine Sciences.